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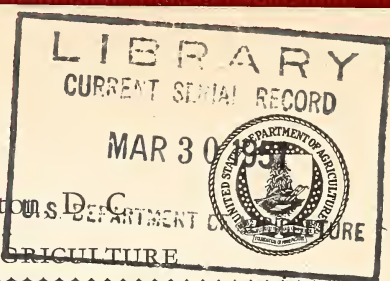
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Managing Northern Great Plains Cattle Ranges to Minimize Effects of Drought

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INTRODUCTION

In that part of the western range country known as the northern Great Plains, the semiarid climate imposes a very delicate balance between favorable and unfavorable growing conditions. A small decline below average annual precipitation may result in reduced growth or even in total failure of all but the most drought-resistant forage plants.

Among stockmen, a favorable year or two often encourages undue optimism and an unwise effort to make up for the losses of past, less favorable seasons, by expanding livestock numbers. But wishing will not change the weather. Seldom a series of 5 years goes by without a year of drought, or at least a very dry year. The operator who has expanded his livestock in expectation of another favorable year is loath to sell his

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animals on a declining market until the threat of drought becomes a certainty. Then it is likely to be too late. The result is a setback that the individual and the industry as a whole can ill afford.

Worse than a single drought or dry year is a succession of such years. In such a period the operator who has made a practice of grazing his range to the limit of usable forage finds to his dismay that the interval between such droughts is insufficient for the forage to regain its vigor. As a result, the second year of drought hits harder than the first, and for the operator it may well mean ruin.

Dependable knowledge of what to expect and what to provide for to meet these unpredictable but inescapable drought years makes it possible to forearm the livestock industry and thereby prevent ruinous losses. Such forearming is particularly necessary in prosperous years when an operator may be more than ever tempted to discount future safety for present high returns. Of especial value, then, is the record of what happened to a group of experimental range pastures in the northern Great Plains and to the range cattle grazing on them when the severe droughts of 1934 and 1936 swept over the area. The record shows unmistakably the advantages of moderate and light stocking for cattle production in drought years. It also makes clear fairly specific guides that can insure the producer smaller losses and survival when the next drought strikes.

WHAT DROUGHT IS ON NORTHERN GREAT PLAINS RANGES

In the northern Great Plains, as in many other parts of the western range, there is always a possibility that next year may be a drought year. Here the average drought frequency over long periods is once in 5 years. Proof of this rather frequent occurrence of drought and consideration of the nature of such a drought season are worthy of attention.

A study of Weather Bureau records at Miles City, Mont., for 62 years, 1878 through 1939, reveals that the average annual precipitation of about 13 inches falls in two distinct periods. Thirty percent of it (roughly 4 inches) falls between October 1 and March 31, and 70 percent (9 inches) falls between April 1 and September 30. The 70 percent in the spring and summer growing season has a far greater influence upon forage production than the 30 percent that occurs in the nongrowing season—so much so that shortage of precipitation in spring and summer is a true measure of drought, whereas a similar or greater relative shortage in winter is not.

Every drop of the scanty growing-season rainfall is needed, and the 62-year record indicates that if total rainfall is less than 70 percent of the 9.18-inch spring-summer average, or 6.4 inches, the effects on the range are usually so serious as to cause a condition of drought. However, distribution of rainfall throughout the growing season may be the deciding factor. Normally the distribution is about as follows:

	<i>Inches</i>	<i>Percent</i>
April.....	1.05	11
May.....	2.04	22
June.....	2.57	28
July.....	1.51	17
August.....	1.06	12
September.....	.95	10
Total.....	9.18	100

Any serious deficiency during the first 4 months of the growing season, represented by monthly rainfall substantially lower than these amounts, is sure to result in seriously retarded plant growth. On the other hand, moderately lighter-than-average rainfall during the summer months if normally distributed will probably prevent drought conditions. A year with precipitation only a little below the average for the growing season may be referred to as a dry rather than a drought year. The difference between dry and drought years may be considerable in terms of forage growth.

Frequency of drought is one of the most significant features of the 62-year record at Miles City (fig. 1). Thirteen years brought drought conditions. Nine years fell below 6.4 inches of growing-season rainfall. A tenth, 1917, came close to 6.4 but had rather well-distributed rainfall. Four years, 1881, 1890, 1900, and 1937, received more than 6.4 inches of rainfall but had four or more very dry months during the growing season and were considered drought years. The Miles City average of one drought in 5 years is a typical example of northern Great Plains weather, and is substantiated by a 60-year record, ending in 1939, at Havre, Mont., not far from the Canadian border and about 250 miles northwest of Miles City.

If this average represented the regular interval between drought years, planning of range grazing practices to anticipate the problems presented, would be considerably simplified. On the contrary, never has drought occurred regularly every fifth year. The record at Miles City shows that there were several dry years in the decade 1881-90, three at the beginning, one in the middle, and one real drought year at the end. The next drought struck 7 years later; and in the next 7 years, another occurred. All of the

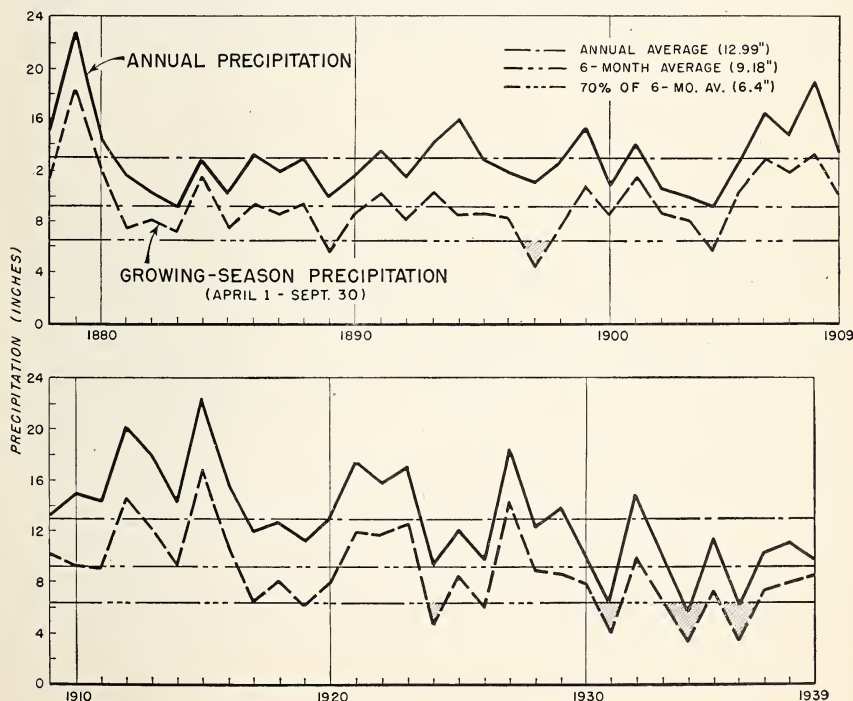


FIGURE 1.—Summary of precipitation record at Miles City, Mont., 1878-1939 (U. S. Weather Bureau data).

next 12 years (1905-16) were favorable. The marginal year 1917 was a forerunner, however, of the drought year 1919. In the next decade the average of 2 drought years in 10 was maintained, but these 2 droughts fell only 2 years apart, with a fairly dry year between. The decade 1930-39 was especially unfavorable. There were three drought years, and rainfall in all years but one was well below the average of 9.18 inches that is usually satisfactory for the growing season.

The grouping of drought seasons, exemplified in the 1920-29 and 1930-39 decades, produces cumulative effects that cause acute distress. For the 1930-39 decade, growing-season precipitation at Miles City averaged only 6.7 inches, very close to drought margin for the whole period. It further included three of the most disastrous droughts of which we have knowledge, and the rainfall in two of the intervening years, 1933 and 1935, was subnormal. In the years of severe drought, rainfall was only 38 to 44 percent of average during the 6-month summer seasons, and this combined with abnormally high temperatures and hot winds caused the death of a major part of the range plants and widespread trouble in the range livestock industry.

The year 1934 illustrates well the crushing losses that can come to range livestock operators during a severe drought. As a result of the 1934 drought, the Federal Government purchased 7.2 million cattle and 3.6 million sheep in 16 Western States in an effort to prevent utter demoralization of the industry (7).² The average price of \$13.40 per head for cattle, all grades and ages included, was but a small fraction of their true value under normal conditions.

Within the northern Great Plains region more than 2.5 million cattle were purchased from about 140,000 ranchers. In proportion of total cattle inventory for ranches participating, these forced sales ranged from 31 to 64 percent. Great numbers of drought-stricken livestock, including breeding herds that had been built up by painstaking effort, were sacrificed in 1934 and 1936. Though some owners who had feed reserves fared much better, many ranchers sold more than 90 percent of their cattle during these drought years. In such times, staggering losses from starvation and low prices have been the rule rather than the exception. For this reason drought must be regarded as a factor of major significance in the whole economic and social fabric of the region (1).

HOW DROUGHT EFFECTS WERE STUDIED

Situated near Miles City in southeastern Montana, the experimental area is part of the United States Range Livestock Experiment Station, a tract of 56,300 acres that was formerly a military reservation and was transferred to the Department of Agriculture in 1923. The portion used in this experiment embraced 1,847 acres of typical short-grass range. Vegetation was in good condition; cattle were carefully selected; experimental materials were suitable for the study of the droughts that struck in 1934 and 1936.

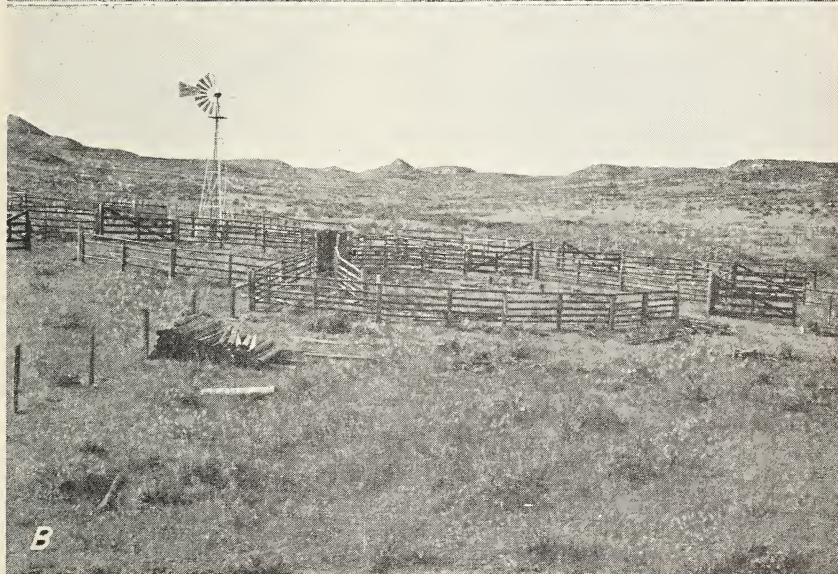
THE EXPERIMENTAL AREAS

Two representative areas of northern Great Plains range were chosen for the study (fig. 2). One area of level to gently rolling range containing 845 acres was used for grazing in the summer period from May 15 to November 15. For winter, November 15 to May 15, an area of 1,002 acres was located

² Numbers in parentheses refer to Literature Cited, p. 24.

in rougher country to afford protection for cattle and windswept ridges for grazing.

The study began in July 1932 and continued until August 1936—a 4-year period which included two severe drought years and an intervening year of below normal rainfall. Although vegetation was typical of the region's



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FIGURE 2.—*A*, Gently rolling range around the central well was chosen for the summer experimental pastures. *B*, Winter range pastures were located in rougher country for protection from storms.

short-grass range, it was in better than average condition. Conservative use and good management previous to the start of the experiment and several years of good rainfall had combined to produce forage at or near the optimum of vigor and density.

Principal grass and grasslike species were blue grama,³ bluestem wheat-grass, needle-and-thread grass, buffalograss, Sandberg bluegrass, and threadleaf sedge. Silver sagebrush, together with some shadscale and fourwing saltbush provided browse on the winter range and during drought periods.

The summer and winter range areas were each divided into three pairs of pastures radiating from the central well and handling facilities (fig. 3).

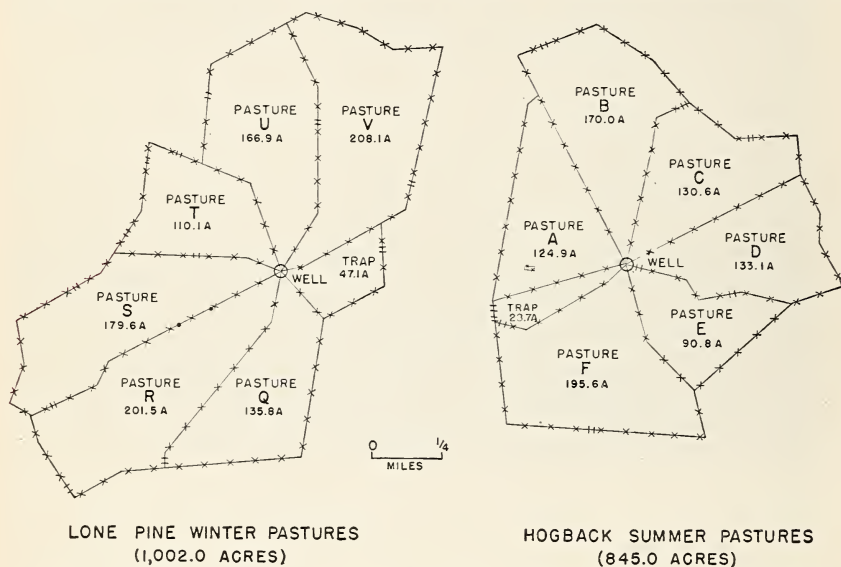


FIGURE 3.—Experimental pastures at the United States Range Livestock Experiment Station.

This arrangement made it possible to graze 6 groups of 10 cows under 3 rates of stocking. Pasture size, rather than numbers of animals, was varied to obtain different rates of stocking, and pasture size was determined by a survey of forage acres available in 1932 instead of by surface acreage. Forage acres were calculated as follows: Surface acres times the estimated density of the vegetation, times an assumed proper-use percent for the various forage species.

Through moderate stocking it was aimed to provide enough forage to keep the cattle in satisfactory thrift without unnecessary shortage or surplus under average growing conditions. Heavy stocking was about 30 percent greater than moderate, while light stocking was designed to leave a substantial reserve of unused forage in all but very dry or drought years.

Four moderately stocked pastures (130.6 and 133.1 acres in summer, 166.9 and 179.6 in winter) gave an average of 30.5 acres (8.05 forage acres) per cow yearlong. Four heavily stocked pastures (90.8 and 124.9 acres in summer, 110.1 and 135.8 acres in winter) provided an average of 23.1 acres (5.69 forage acres) per cow yearlong; and four lightly stocked pastures (170.0 and 195.6 acres in summer, 208.1 and 201.5 acres in winter) provided 38.8 surface acres (10.04 forage acres) per cow for a year.

³ The scientific names of species mentioned are given on p. 24.

THE CATTLE

Cows used in the experiment were uniform 2-year-old heifers (fig. 4). They were selected from a large herd of high-quality range Herefords developed from registered cows and bulls at the United States Range Livestock Experiment Station. When placed on the range in 1932, 3 lots of 20 heifers were assigned to the 3 rates of stocking, 10 to a pasture.



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FIGURE 4.—An experimental group of cows at the beginning of the winter grazing period, December 1, 1933. Paint brands were used to distinguish individuals quickly in weighing.

Nineteen of the original cows were replaced by comparable animals during the 4 years of study. Ten died during severe weather in February 1936 when minimum temperatures ranged from 5 to 45° F. below zero for 21 consecutive days. Nine other cows were replaced because of cancer eye, lumpy jaw, accidental injury, or failure to calve for two consecutive years.

One registered bull was used in each of the six summer range pastures. The breeding season was limited to approximately 7 weeks, beginning late in June or early July; calves were dropped during April and early May. Baled alfalfa hay produced locally by cooperating agencies was used for supplemental feed. Salt and bonemeal in a 3 to 1 mixture was fed in boxes located so as to encourage uniform forage utilization. Tank heaters were used in the winter water tank to prevent freezing.

THE RECORDS

Detailed records were kept of how the range and cattle were affected by weather and the three rates of stocking. Vegetation trends were determined by annual measurements of density on a series of 52 meter-square quadrats, which gave a fair sample of conditions, especially on the summer range pastures. Other records included: Estimated forage utilization by seasons, plant growth and development, amount of hay fed to each group of cows, and individual cow and calf weights recorded at 28-day intervals.

DROUGHT SEVERELY DIMINISHED RANGE VEGETATION

As the first of the two most severe drought years of record struck in eastern Montana, range vegetation showed unmistakable signs of the impending disaster. Poor color, short growth, and early curing characterized plant development in 1934. By early July scanty vegetation on many ranges threatened livestock with starvation. In 1936 available range forage, largely old vegetation carried over from the 1935 production, rapidly disappeared as hordes of grasshoppers invaded the range. It was necessary to remove experimental cattle from the summer pastures in early August to avoid excessive costs of maintaining them. By early summer in 1937 less than 10 percent of the 1933 plant cover remained on the experimental range pastures.

DENSITY OF PLANT COVER GREATLY REDUCED

The extent of the decline in density of plant cover was revealed by actual measurement of the surface area within meter-square quadrats covered by representative plants of the experimental ranges (table 1). Over the 4-year period 1934-37, density of the six most important forage species fell to 8.5 percent of the 1933 level. Decreases in density under the three intensities of stocking, in both summer and winter pastures, were remarkably close to this average decline. Moreover, on plots entirely ungrazed, the trends in density of the principal species were sharply downward from 1935 to 1937.

TABLE 1.—*Density of plant cover on grazed, meter-square quadrats,¹ 1933-37*

Item	1933	1934	1935	1936	1937	Percent change, 1933-37
Dominant species:	<i>cm.</i> ²	<i>cm.</i> ²	<i>cm.</i> ²	<i>cm.</i> ²	<i>cm.</i> ²	
Blue grama.....	1, 629	1, 287	407	418	74	-95. 5
Buffalograss.....	731	477	178	243	30	-95. 9
Bluestem wheatgrass.....	190	79	41	74	23	-87. 9
Threadleaf sedge.....	53	44	46	30	24	-54. 7
Sandberg bluegrass.....	44	35	119	85	77	+75. 0
Needle-and-thread.....	44	26	17	23	1	-97. 7
Total or average.....	2, 691	1, 948	808	873	229	-91. 5
Other perennial grasses.....	85	32	6	11	1	-98. 8
Annual grasses.....	44	24	7	49	5	-88. 6
Weeds.....	58	11	5	6	10	-82. 8
Browse.....	9	5	0	2	0	-100. 0
Plains pricklypear (cactus).....	42	12	19	22	25	+108. 3
Total or average all species.....	2, 899	2, 032	845	963	270	-90. 7
Total density.....	<i>Pct.</i> 100	<i>Pct.</i> 70. 1	<i>Pct.</i> 29. 1	<i>Pct.</i> 33. 2	<i>Pct.</i> 9. 3	-----

¹ Based on 52 quadrats in all pastures originally measured in 1933.

At the same time that drought caused the most palatable forage plants to decline to very low levels of density, less desirable plants became major constituents of the stand. For example two of the most important species, blue grama and buffalograss, dropped to less than 5 percent of predrought density, and a third, bluestem wheatgrass, declined to 12.1 percent of its

1933 level. These three species furnish the bulk of summer and winter forage. Threadleaf sedge declined to about half of its predrought density. But Sandberg bluegrass, an early species of limited value for late grazing, actually increased 75 percent. The increase in Sandberg bluegrass occurred because established plants enlarged and became more vigorous as the less hardy and later starting species died out and so lessened competition for soil moisture. Its highest density level was attained in 1935; then, as more of the grazing load was shifted to this species, density declined.

Other less important species also showed a wide variation in their reaction to drought. Silver sagebrush, important as a winter forage plant, had 122 live plants on one series of 15 plots in 1934; it had only 9 live plants in 1937. On the other hand, plains pricklypear, of only incidental value as emergency feed and as protection from erosion, increased so during the drought years that it became a cause for concern in later, more favorable seasons (3). Low-value annuals, moderately effective in holding topsoil against wind erosion, appeared in limited quantity as the better species declined. Even though these temporary species increased in percentage of the stand by the summer of 1937, they did not replace the lost density of better species.

The record of density changes given in table 1 also brings out another harsh aspect of drought on northern Great Plains ranges—a cumulative effect. In the first drought year, 1934, density fell to 70 percent of its 1933 level. In spite of more favorable rainfall in 1935, plant cover fell to 29 percent of the 1933 level, and plummeted from 33 percent in 1936 to 9 percent by 1937.

DROUGHT ALSO REDUCED FORAGE SUPPLY

Of direct concern to stockmen was the effect of drought on forage supply. The record of animal-months of grazing provided by experimental range pastures for 60 cows and their calves (table 2), while they subsisted entirely on range forage, brings out strikingly the great reduction in grazing use in the 1934 and 1936 drought years. Only 36 and 23 percent as much unsupplemented grazing use, measured in animal-months, was obtained from the pastures in these 2 years as in 1933.

TABLE 2.—*Animal-months of unsupplemented grazing furnished for 60 cows and their calves each year by the experimental pastures*

Yearly period beginning in May	Animal-months of grazing			Percent of first full year
	All cows	All calves ¹	Total	
1932 ² -----	558. 9	0	558. 9	72. 3
1933 -----	716. 1	56. 9	773. 0	100. 0
1934 -----	252. 4	29. 2	281. 6	36. 4
1935 -----	503. 0	44. 7	547. 7	70. 9
1936 ³ -----	153. 3	22. 9	176. 2	22. 8

¹ Calf grazing converted to animal-months on 5 to 1 ratio.

² 10 months only, beginning July 14, 1932; forage not fully utilized during this initial period.

³ Cattle removed from pastures in early Aug. because of lack of forage.

Only a part of the actual decline in forage production is reflected by the comparisons in table 2, because cattle grazed the range more closely during drought years than during 1933 and still failed to maintain normal weight trends.

It is noteworthy that grasshoppers, as well as the cattle, greatly preferred the current year's green vegetation to carry-over dry herbage. The grasshoppers often ate the new herbage as fast as it grew, leaving the old herbage, which they sometimes cut off, for the cattle (fig. 5). Under these conditions the old herbage was taken eagerly by cattle and, where abundant, it provided maintenance forage.

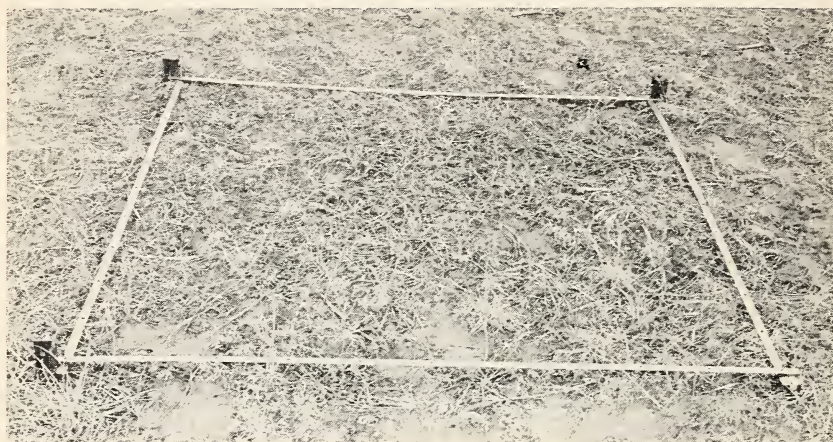


FIGURE 5.—Even on plots protected from livestock nearly all of the vegetation was eaten or cut off by grasshoppers.

DROUGHT INCREASED SUPPLEMENTAL FEEDING

Cows on the experimental range needed remarkably little supplemental hay in the first years of the test, but requirements jumped tenfold when drought struck. Because range forage was inadequate, hay feeding became a necessity to prevent starvation rather than a means to offset the effects of winter snow and cold.

Only 430 pounds of hay per cow during the winter of 1932-33 and 170 pounds during the second winter proved sufficient (table 3). This shows that supplemental feed requirements for breeding cows may be very low under favorable range conditions.

During the first year, when rainfall and range forage were adequate, cows needed less than one-fourth of a ton of hay to withstand about a month of severe weather beginning late in January. Fairly good rainfall and range conditions in the 6 months before the 1933 growing season helped provide more animal-months of grazing and as a result less than one-tenth of a ton of hay was needed the second winter. After drought started, however, cows required much more supplemental feed, some during the summer, and the cumulative effect of inadequate rainfall and insufficient range forage was dramatically demonstrated. Hay requirements jumped to nearly $2\frac{1}{2}$ tons per cow in the 1934 drought year, when growing-season rainfall was one-third that of the first year and animal-months of grazing were only half of the first year level. In 1935, animal-months of grazing increased again, but plant density had so decreased that almost three-fourths of a ton of hay per cow was required that year in spite of higher rainfall during the growing season.

TABLE 3.—*Range forage in animal-months of unsupplemented grazing and supplemental hay provided for 60 cows, by seasons, in relation to precipitation, 1932-36*

Season	Animal-months of grazing	Hay fed		Precipitation	
		Total	Average per cow	12 months ¹	Growing season ²
	<i>Number</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Inches</i>	<i>Inches</i>
Summer 1932-----	289	0	0	-----	-----
Winter 1932-33-----	270	25, 800	430	-----	-----
Total-----	559	25, 800	430	13. 36	10. 07
Summer 1933-----	438	0	0	-----	-----
Winter 1933-34-----	335	10, 200	170	-----	-----
Total-----	773	10, 200	170	11. 62	6. 44
Summer 1934-----	237	82, 792	1, 380	-----	-----
Winter 1934-35-----	45	209, 571	3, 493	-----	-----
Total-----	282	292, 363	4, 873	6. 34	3. 53
Summer 1935-----	372	5, 416	90	-----	-----
Winter 1935-36-----	176	80, 980	1, 350	-----	-----
Total-----	548	86, 396	1, 440	10. 41	7. 54
Summer 1936 ³ -----	176	16, 548	276	6. 66	3. 58

¹ Includes current growing season plus previous 6 months, October to April.² Includes April through September, current year.³ Cattle removed from pastures Aug. 7, 1936.

By 1936 forage was so sparse that it became necessary to feed the cows on the heavily stocked range beginning about July 10. The cows on moderately and lightly stocked range, however, subsisted on range forage without supplements about 20 days beyond that date. In early August it was evident that all lots of experimental cattle would have to be fed until another crop of range forage was produced. Because this would have been a costly, impractical method of handling the cattle they were removed from the pastures and the grazing trial temporarily discontinued on August 7.

The semiarid climate, storage difficulties, and expense involved all limit the amount of supplemental feed that can be produced and accumulated in the northern Great Plains. Yet without adequate feed reserves the threat of disaster implied in the region's history of recurring drought will always face livestock operators. Rate of stocking is a practical means of adjustment to reduce supplemental feed requirements.

As records summarized in table 4 show, cows on heavily stocked ranges had to be fed on more days, required more hay, and in the summer of 1935 needed feed when cows on moderately and lightly stocked ranges needed none. The combination of drought and heavy stocking meant extra penalties in labor, time, and supplemental feed. The fact that increased feeding during drought is made more burdensome by heavy stocking is illustrated by the 1934 drought year. Including the period from early summer of that year until grass became available again the next spring, the three groups were fed per cow unit for a specified number of days as follows: Heavily

TABLE 4.—*Hay fed to cows under three rates of range stocking,¹ 1932-36*

Season	Heavy stocking			Moderate stocking			Light stocking		
	Days fed	Total feed	Average hay fed per cow	Days fed	Total feed	Average hay fed per cow	Days fed	Total feed	Average hay fed per cow
Winter 1932-33	Number	Pounds	Pounds	Number	Pounds	Pounds	Number	Pounds	Pounds
Winter 1933-34	27	8,600	430	27	8,600	430	27	8,600	430
	16	3,400	170	16	3,400	170	16	3,400	170
Summer 1934	126	40,501	2,025	79	25,337	1,267	49	16,954	848
Winter 1934-35	167	71,363	3,568	151	69,104	3,455	151	69,104	3,455
Total	293	111,864	5,593	230	94,441	4,722	200	86,058	4,303
Summer 1935	27	5,416	271	0	0	0	0	0	0
Winter 1935-36	131	36,248	1,812	110	23,596	1,180	89	21,136	1,057
Total	158	41,664	2,083	110	23,596	1,180	89	21,136	1,057
Summer 1936 ³	27	12,467	623	4	2,308	115	4	1,773	89
Aggregate	521	177,995	8,900	387	132,345	6,617	336	120,967	6,048
Average per cow									

¹ 20 cows assigned to each rate of stocking.² There was no supplemental feeding in the summers of 1932 and 1933.³ Feeding ended Aug. 7, 1936, when cattle were removed from experimental ranges.

stocked, 2.80 tons, 293 days; moderately stocked, 2.36 tons, 230 days; lightly stocked, 2.15 tons, 200 days.

Conservative stocking ⁴ with a supplemental feeding average of 2¼ tons per cow, was equivalent to a saving of half a ton per head when compared to heavy stocking. Ordinarily, the expense of providing 2.8 tons of hay per cow when hay is scarce and high priced would be prohibitive even on ranches that have unusual capacity for production and storage of feed. In any event, maintaining a reserve of hay large enough to sustain the entire range herd throughout severe drought is physically and financially impracticable on most ranches.

However, before reckoning the final toll of drought or evaluating the advantage of conservative stocking as a means of decreasing that toll, the reduced weight and value of cattle produced and the extra cost of supplemental feeding must be considered.

DROUGHT REDUCED CATTLE PRODUCTION

COW WEIGHTS DECLINED

As a result of decreased range forage, cattle production suffered a sharp decline. During drought the cows failed to make their usual seasonal weight gains. The calf crop fell off. Calves were stunted and of poorer quality for marketing.

Twice each year breeding cows must be carried through periods when weight is of first-rank importance. These critical periods are at the close of the winter season when calves are being dropped, and at the close of the summer season when cows are starting into the winter.

Drought reversed the natural tendency of cattle to add weight in the summer period. Although experimental cows gained 60 to 233 pounds during the summers of 1932, 1933, and 1935,⁵ they lost weight in 1934 and 1936 even with supplemental feeding (table 5). Likewise, cows that gained 15 pounds in the winter previous to the 1934 drought actually lost weight during the drought winter. This effect of the drought was evident even though considerable feed was provided.

TABLE 5.—*Average weight of 60 experimental cows at end of winter and summer grazing periods,¹ 1932-36*

Year and age of cows	Average weight		Weight gain or loss	
	At close of winter	At close of summer	During summer	During winter
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1932, 2-year-old dry heifers.....	703. 3	936. 6	² +233. 3	—96. 1
1933, 3-year-old cows.....	840. 5	948. 6	+108. 1	+14. 9
1934, 4-year-old cows.....	963. 5	³ 903. 5	—60. 0	—4. 0
1935, 5-year-old cows.....	899. 5	959. 9	+60. 4	+9. 9
1936, 6-year-old cows.....	969. 8	⁴ 948. 5	—21. 3	-----

¹ Summer period from about May 15 to Nov. 15; winter from about Nov. 15 to May 15.

² From June 9, before experiment began on July 14, to Dec. 1.

³ Drought year; considerable hay feeding required.

⁴ Drought year; hay feeding necessary in July for a few cows.

⁵ Moderate and light stocking averaged 35 acres per cow per year.

⁶ In 1935 the weight gain was possible even with greatly reduced vegetative density because grass grew unusually tall that year.

The time when breeding cows reach peak weights is also important to livestock growers because it determines when cattle may be marketed to best advantage. Severe drought may mean that a rancher is faced with the double problem of stretching a small feed supply while maintaining his herd's ability to survive. In such a predicament selling cattle may be the only solution. Of particular interest to ranchers, then, is the fact that in drought years cows begin to lose weight earlier than in favorable years.

The time of peak weight differs for dry and wet cows, but both types are affected by drought. Dry cows are salable at any time and should be among the first to go in case of drought; wet cows, however, are less readily moved and disposed of because of their poorer condition and the calves at their sides. Table 6 shows that in 1933 and 1935 the dry cows reached their peak weight later than the wet cows. During the drought years, dry and wet cows reached peak weight simultaneously. Early sale of dry cows, particularly during drought, is important because ranchers will get higher returns for the greater weight and at the same time save forage for the wet cows they retain.

TABLE 6.—Average weight of wet and dry cows ¹ at various intervals, 1933-36

Date	1933		1934 ²		1935 ³		1936 ⁴	
	6 dry	54 wet	16 dry	44 wet	18 dry	42 wet	12 dry	48 wet
May 12-----	864	838						
15-----			979	958	912	894	975	969
June 9-----	960	916						
12-----			⁵ 1,034	984	1,012	979	1,074	1,030
July 7-----	1,021	979						
10-----			1,034	962	1,101	1,047	1,046	965
20-----			1,027	956				
Aug. 4-----	1,065	1,023						
7-----					1,113	1,033	1,014	932
17-----			1,010	913				
Sept. 1-----	1,067	991						
4-----					1,104	999		
14-----			981	870				
29-----	1,077	995						
Oct. 2-----					1,124	997		
5-----			987	883				
18-----			990	872				
27-----	1,077	963						
30-----					1,059	917		
Nov. 13-----	1,058	937						

¹ Includes 60 cows, 20 each in heavy, moderate, and light stocking groups.

² Hay feeding started July 20, Sept. 5, and Sept. 14, respectively, in heavily, moderately, and lightly stocked pastures. Calves weaned Oct. 5.

³ Hay fed Oct. 3 through 30 on heavily stocked pastures. Calves weaned Oct. 30.

⁴ Hay feeding started July 10 on heavily stocked pastures; Aug. 3 on others.

⁵ Figures in heavy type represent peak weights.

Cows with calves reached their highest weight levels in early August of 1933 and early July of 1935. However, the peak came in June during both drought years, and hay fed during the late summer failed to bring the weight of wet cows back to June levels.

In the same manner, dry cows, which had continued to gain into late September or early October in 1933 and 1935, reached peak weights in early

June during drought years and then declined in spite of supplemental hay feeding. Worth noticing is the fact that even in the years with favorable rainfall, the average gain for dry cows after early August was only 11 to 12 pounds—a small return for almost 2 months of care, forage, and risk in holding them.

WEIGHT AND QUALITY OF CALVES DECLINED

The lowest calf crop—70 percent of weaned calves—occurred in 1935 (table 7), in contrast to an average of 81 percent for the other 3 years. This disparity (in accord with the usual experience that drought reduces the calf crop of the following rather than the current year) came after the 1934 drought had caused cows to lose weight during the current breeding season and in the following winter. Since most cows were sold in 1936 there was no recorded 1937 calf crop to show the effect of the 1936 drought. However, Bureau of Animal Industry records at Miles City, Mont., show that the 1937 calf crop was one of the lowest in recent years.

The 60 cows received the best practicable care, yet in terms of total calf weight they produced 10,430 fewer pounds in the two drought years than in the other 2 years—a serious weight loss that averaged 99 pounds per calf. This difference in weight, more than 5 tons, meant that drought caused a 33 percent loss in total calf production! Furthermore, the higher total weight of 1933 and 1935 was realized even though there was a short calf crop in 1935.

TABLE 7.—*Number and average weight of calves weaned from 60 experimental cows, 1933-36.*¹

Year	Calves	Calf crop	Weight of calves	
			Total	Average
	Number	Percent	Pounds	Pounds
1933.....	54	90. 0	16, 850	312. 0
1934 ²	44	73. 3	11, 765	267. 4
1935.....	42	70. 0	14, 771	351. 7
1936 ²	48	80. 0	9, 426	196. 4

¹ Calves averaged 5½ months of age at weaning except in 1936 when they were weaned at 3¼ months.

² Drought year.

Market quality is an important measure of calf production. Normally, calves from 4- and 6-year-old cows are heavier (5) than those from 3- and 5-year-old cows, respectively; but with drought intervening, older cows produced the lighter calves (table 7). Then, too, the shortage of forage developed so early during drought years that calves had to be weaned earlier than normal to prevent starvation of both cows and offspring. A concrete example illustrates how unsatisfactory calf development was when drought set in: Market quality of drought-stricken calves so decreased that thousands of "dried-out dogies" from Great Plains ranges sold for a maximum of \$8 per head during the Federal drought-relief purchase program. Much of the effort by cattlemen to improve herds by culling and by purchasing better sires is thwarted by drought. Well-bred calves are so retarded in growth and development that they sell at the level of scrubs.

INFLUENCE OF RATE OF STOCKING

Although subnormal weights and losses instead of gains cannot be entirely avoided when drought prevails, observations made on the experimental ranges indicate that through conservative stocking weight losses can be minimized. Conservative stocking stands out as one very effective way of doing something about the weather.

At the start of the experiment the cattle were uniform in weight. As bred 2-year-old heifers, weights varied only 3.7 pounds on the average between the lots on heavily and conservatively stocked range (table 8). By the end of the first summer and consistently thereafter, cows on heavily stocked range weighed less than their counterparts on conservatively stocked ranges. More important is the fact that weight differences were well marked at the critical fall and spring periods. Heavy stocking handicapped cows with young calves; at the close of winter periods they were 52 to 111 pounds lighter than cows on moderately and lightly stocked range even though they received more supplemental hay during the winter. Again, cows from heavily stocked ranges were at a disadvantage in meeting winter's severe weather because of weight differences of 39 to 91 pounds in the fall.

TABLE 8.—Average cow weight by rates of stocking at critical periods, 1932-36

Year and period	Weight of cows on conservatively stocked range ¹	Weight of cows on heavily stocked range ²	Weight difference
1932: ³	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Start of experiment (July 14) -----	898. 4	894. 7	3. 7
End of summer -----	955. 7	898. 5	57. 2
1933:			
End of winter -----	857. 9	805. 6	52. 3
End of summer -----	978. 9	888. 2	90. 7
1934:			
End of winter -----	982. 1	926. 4	55. 7
End of summer ⁴ -----	918. 5	873. 6	44. 9
1935:			
End of winter -----	917. 9	862. 7	55. 2
End of summer -----	977. 7	924. 2	53. 5
1936:			
End of winter -----	1, 006. 9	895. 5	111. 4
August, when cows were removed -----	961. 5	922. 6	38. 9

¹ Average of 40 cows, 20 each on moderately and lightly stocked ranges.

² Average of 20 cows on heavily stocked range.

³ Experimental animals were bred 2-year-old heifers in 1932, largely wet cows thereafter.

⁴ Hay feeding began in July on heavily stocked ranges and in early September on conservatively stocked ranges.

In terms of calf production, drought cut much more deeply into weights on heavily stocked ranges than it did on moderately and lightly stocked ranges. For example, the total weaning weight of calves from 20 cows on heavily stocked range in the 2 years, 1934 and 1936 combined, was only 5,385 pounds (table 9), while in the "good year" of 1933 cows on the heavily stocked range produced 5,280 pounds—a difference of only 105

TABLE 9.—*Number and average weight of calves weaned from 60 cows, 20 each on heavily, moderately, and lightly stocked range, 1933-36*

Year and calf crop	Heavily stocked			Moderately stocked			Lightly stocked		
	Calves	Weaning weight		Calves	Weaning weight		Calves	Weaning weight	
		Total	Average		Total	Average		Total	Average
1933—1st crop ¹	Number	Pounds	Pounds	Number	Pounds	Pounds	Number	Pounds	Pounds
1934—2d crop ²	18	5,280	293.3	19	6,060	318.9	17	5,510	324.1
1935—3d crop ³	12	2,624	218.7	18	5,066	281.4	14	4,075	291.1
1936—4th crop ⁴	12	3,766	313.8	15	5,580	372.0	15	5,425	361.7
	16	2,761	172.6	16	3,260	203.8	16	3,405	212.8
Total	58	14,431	-----	68	19,966	-----	62	18,415	-----
Average	14.5	-----	248.8	17.0	-----	293.6	15.5	-----	297.0

¹ Weaned Oct. 18 at 6 months or less average age.² Weaned Oct. 5 at approximately 5 months average age.³ Weaned Oct. 30 at 6 months or less average age.⁴ Weaned Aug. 7 at approximately 3¼ months average age.

pounds. On moderately and lightly stocked ranges in the same years, combined drought weights were about 2,000 pounds heavier than the 1933 weight. Furthermore, the entire crop of calves from heavily stocked ranges weighed 5,535 pounds less than those from moderately stocked, and 3,984 pounds less than calves raised on lightly stocked ranges.

The fact that moderately and lightly stocked ranges produced calves averaging 44.8 and 48.2 pounds more at weaning time than heavily stocked ranges accounts for only part of the total weight differences. Greater numbers of calves also contributed to the higher total weights on moderately and lightly stocked ranges.

DROUGHT INCREASED COSTS AND LOWERED RETURNS

Besides such physical losses as depleted range and lightweight cattle, drought brought serious financial loss through greatly increased feeding costs and reduced returns from cattle production. Because of tenfold larger supplemental feed requirements and increased cost of hay, drought years multiplied feeding costs many times.

Hay was not purchased for the experimental herd because an ample supply had been produced and stored at the experiment station. Using an estimated average cost of loose hay in eastern Montana plus a transportation and baling charge of \$3 per ton, and feed data from table 3, the following tabulation of approximate supplemental feeding charges on the experimental range illustrates in a minor degree the pyramiding of costs in drought years.

	<i>Cost</i>		
	<i>Hay cost per ton¹</i>	<i>Total hay cost</i>	<i>Hay cost per cow</i>
Winter 1932-33.....	\$7. 50	\$96. 75	\$1. 61
Winter 1933-34.....	9. 00	45. 90	. 77
Summer 1934 (drought) and winter 1934-35.....	17. 40	2, 543. 56	42. 39
Summer 1935 and winter 1935-36.....	13. 50	583. 17	9. 72
Summer 1936.....	19. 25	159. 27	2. 65

¹ Bureau of Agricultural Economics estimate of prices of loose hay for eastern Montana plus \$3 per ton for baling and transportation.

Feeding lasted only a few weeks in the summer of 1936, because cattle on the range were sold in order to save what hay was available at the station for other experimental cattle. In that year drought prices of hay actually rose to \$20 or more a ton in some instances. For those operators who have to buy hay, maximum prices often mean financial ruin. In addition to the dollar value of hay fed during drought, ranchers must count the extra labor involved in increased handling and feeding.

Other costs also increased because cows ate much more salt and bonemeal in drought years. In the summer of 1933, 0.7 to 0.8 pound of a 3 to 1 mixture was used per cow month. During the early summer of 1934, cows used two to four times as much (4). After hay feeding was started, use of the mixture declined to about the same level as for the previous summer.

Calf production on experimental ranges provides a suitable means of evaluating the effect of drought on livestock returns. Using average calf weights from table 7 and assigning Bureau of Agricultural Economics

estimated average prices of calves, value per calf during the 4 years of the test would be as follows:

Year	Average weaned calf weight (pounds)	Estimated BAE prices (per cwt.)	Average value per calf at BAE prices
1933	312.0	\$5.05	\$15.76
1934 ¹	267.4	5.15	13.77
1935	351.7	6.75	23.74
1936 ¹	196.4	5.40	10.61

¹ Drought year.

Figuring forage at an annual rental of 10 cents per acre, cost of maintaining the experimental breeding cows was:

Year	Hay cost per cow	Forage cost per cow	Total cost per cow
1933	\$0.77	\$3.08	\$3.85
1934 ¹	42.39	3.08	45.47
1935	9.72	3.08	12.80

¹ Drought year.

Full-year costs for 1936 are not available; the test ended August 7. It is noteworthy that only in 1934 did average feed costs per cow exceed the dollar value per calf.

Another example of the financial penalties imposed by drought is shown by comparing the salvage values of cattle in drought years with those in more favorable years. In 1934 the Federal drought-relief purchase program paid an average of \$13 for stricken cattle, but in 1932 and 1933 the Bureau of Agricultural Economics reported average values of \$24 and \$21 for all cattle and calves in Montana (6).

Conservative stocking is a means of minimizing costs while increasing returns. Using the feed data from table 4 and the Bureau of Agricultural Economics estimated price of loose hay for eastern Montana, plus a transportation and baling charge of \$3 per ton, the following tabulation reveals that heavy stocking imposed extra costs when compared to moderate and light stocking on experimental ranges.

Year	Average cost of hay per cow		
	Heavy stocking	Moderate stocking	Light stocking
1932	\$1.61	\$1.61	\$1.61
1933	.77	.77	.77
1934 ¹	48.66	41.08	37.44
1935	14.06	7.96	7.13
1936 ²	6.00	1.11	.85

¹ Drought year.

² Drought year. Feeding ended August 7—cattle removed from experimental ranges.

Although each of the three rates of stocking had the same hay costs in the first 2 years of the test, once drought had started costs were always greater for cows under heavy stocking than for those on moderately and lightly stocked ranges. Even in 1935, a relatively favorable year, it cost almost twice as much for hay to maintain cows on heavily stocked range as on range stocked at the other two intensities. When the cows were moved from the range pastures early in 1936, the second drought year, feed for cows on heavily stocked range had cost five to seven times as much because the feeding period was 23 days longer.

Hay and annual range rental costs for each stocking group during the entire 4-year test were as follows:

Rate of stocking	Hay cost	Range cost	Total cost
Heavy	\$1,421.99	\$184.64	\$1,606.63
Moderate	1,050.67	244.08	1,294.75
Light	955.99	310.08	1,266.07

Calf production by the cows on the variously stocked ranges provided a measure of returns:

<i>Rate of stocking</i>	<i>Total calf production, weaned weight in pounds</i>	<i>Value at esti- mated BAE prices</i>
Heavy-----	14, 431	\$805. 08
Moderate-----	19, 966	1, 119. 62
Light-----	18, 415	1, 038. 18

The disadvantage of heavy stocking is readily apparent. Calf production from 20 cows under heavy stocking returned \$801.55 less than total feed costs, while moderate stocking returned only \$175.13 less, and light stocking \$227.89 less. Particularly important is the fact that even though moderate and light stocking required greater range acreage than did heavy stocking and thereby had increased range forage costs over the 4-year period, the savings in hay costs during drought materially reduced financial loss.

Since calves were not sold at weaning time, their value computed at the average price per pound each year, as estimated by the Bureau of Agricultural Economics, does not represent the complete difference in returns by rate of stocking. Calves from heavily stocked range were consistently lighter and poorer in market quality than those from moderately and lightly stocked ranges. Undoubtedly the heavier calves from the conservatively stocked ranges would have sold at weaning time for a half cent or more per pound above the heavily stocked group. Moreover, the total feed costs in each of the 3 years, 1934 to 1936, for calves produced under heavy stocking exceeded their market value even though the herd was disposed of on August 7, 1936, while the total market value of calves produced on the moderately and lightly stocked ranges was about 80 percent greater than their total feed costs in both 1935 and 1936.

Salvage values provide a clinching argument for conservative stocking. Forty-two of the 60 cows were culled and sold soon after they were removed from experimental ranges August 7, 1936. Of the 18 cows retained, only 2 of the total from heavily stocked pastures were good enough to be held for future use, as against 6 from moderately and 10 from the lightly stocked groups. Out of 16 calves from each of the three groups 2 were held from heavily stocked ranges, 7 from moderately stocked, and 12 from lightly stocked; all others were sold with their mothers at low prevailing prices.

The price for wet cows, with calves included in the sale, ranged downward from \$43.50 to \$36.00, but most of those that sold at the lowest price were from the heavily stocked group. Four dry cows sold from each group of heavy, moderate, and light stocking averaged 939, 1,038, and 1,065 pounds, respectively. Nine of the best of these dry cows sold for 5 cents a pound on the St. Paul market, and the three others sold for 4 cents. Heavier cows were thus worth an average of \$15 per head more than lighter cows. This difference in salvage value, in addition to lower feed cost, was another very substantial advantage of conservative stocking.

MANAGEMENT PRACTICES TO LESSEN DROUGHT EFFECTS

Long-range planning should insure that cattle and range are maintained in high vigor, and should establish a management pattern readily adapted to emergency action. Such a practical system of management would include plans for action that will lower losses when drought strikes. These objectives can be realized by adhering to the following practices.

BASIC MANAGEMENT PRACTICES

Stock ranges conservatively.—Conservative stocking is a foundation for sound management—it promises heavier cows, greater calf production, and less supplemental feeding. In the experiment, costs were lower and returns greater for cows on conservatively stocked than on heavily stocked range. These advantages were apparent in drought years and in more favorable years, emphasizing the basic soundness of conservative stocking.

On northern short-grass or other comparable ranges in reasonably good condition, at least 31 acres per breeding cow yearlong is recommended as a conservative level of stocking. Since range conditions vary widely in the region, however, utilization of forage is the most reliable indicator of proper stocking. Surveys conducted on the experimental area show that range is conservatively stocked when 45 to 50 percent of bluestem wheat-grass plants are ungrazed at the close of the grazing period in average rainfall years. Ungrazed plants not only remain as a forage reserve for drought years, but also serve to replenish soil nutrients and guard against soil erosion.

Provide supplemental feed.—Stored feed will supplement range forage during severe winters and drought emergencies. The general practice on successful Montana ranches is to maintain a supply of hay in storage equivalent to 1 ton per head of livestock. While the low hay requirements of experimental cattle in the winters of 1932 and 1933 indicate that a ton per head may be more hay than will be needed in many years, some of the surplus can be carried over in the stack for use during dry and drought years. However, under such extreme drought conditions as occurred in 1934 and 1936, when range forage is very sparse or entirely absent, a ton of hay per head will carry only 40 to 50 percent of the herd.

Easily stored concentrates will often help stretch hay supplies during the winter for later use when extreme drought occurs. However, concentrated feeds cannot provide the bulk necessary for maintenance of cattle during drought when range forage and hay are scarce. Moreover, heavy feeding of concentrates for a considerable time, as would be necessary during severe drought, causes serious digestive disturbances. The high cost of such feeds also makes sole dependency upon them during drought impractical (2).

Provide adequate salt and water.—Shortage of stock water is a major problem on many ranges and during drought years may become critical. All other adjustments may be futile unless ample water can be provided for cows and calves during such emergencies. Cows should also have considerably more salt and bonemeal in mixture during drought, to help supply minerals essential for maintaining health and vigor but which may be deficient in range forage.

Establish early, limited breeding.—A breeding season limited to about 2 months, beginning in late June or early July, will result in uniform calves that can be weaned and sold to better advantage than less uniform calves. Besides allowing more leeway for early sales or other adjustments made necessary by drought, early breeding makes branding, vaccination, castration, and weaning possible with a minimum of expense, lost time, and disturbance on the range. Then, too, April and May calves begin grazing early in the season when the forage is green and most nutritious and thus have an advantage over later calves that must learn to graze dry, partly mature forage. The risk of severe March storms on northern Great Plains ranges, however, generally precludes calving before April 1.

Divide the range for seasonal use.—Alternating season of use is more advantageous to both range and cattle than continuous yearlong use of the whole area. Dividing the range for winter and summer use provides fresh forage at the start of the winter period and again in the spring about calving time. With fresh forage available in the fall, cows ordinarily make some gain before severe weather; they are likely to winter better and with less supplemental feed. In the spring, fresh forage helps both cows and calves to start rapid weight gains. Without such a division, the best forage will be grazed before the critical periods in cattle development. Seasonal use also benefits the range by permitting a portion of the plants to produce a seed crop and to store nutrients that enhance their vigor each year. If adequate range is available, a different area should be grazed each spring when growth of the new forage is beginning and the soil is soft and wet.

Insure uniform distribution.—Good distribution of livestock over the range avoids too heavy use of forage on easily accessible areas, around watering places, and at other spots where cattle naturally congregate. It also prevents waste of forage on areas a long distance from water or at places unfavorably located with regard to topography. Obviously, in drought periods uniform distribution is particularly important.

Include steers in the herd.—When drought conditions are extreme, part of the herd must be sold to stretch feed reserves for the maintenance of foundation animals. Steers included in the herd will alleviate the risk of severe losses. It is advisable, however, to graze steers on a range separate from the cows. With such a herd many good breeding cows can frequently be saved from starvation or drought-forced sales by disposing of steers early while they are still in fairly good condition and before available forage is used up. Steers can be moved more easily at any season than can cows with calves, and they usually find a more favorable market.

POSSIBLE DROUGHT ADJUSTMENTS

Even with careful long-range planning, severe drought will cause unavoidable losses through reduced production and increased expense. However, the size of such losses can be trimmed by prompt action that is suggested here and based on experience with drought on the experimental range.

Cull the herd closely.—In surviving a drought, the rancher is especially interested in saving as much of his breeding stock as possible. Obviously, if scant range forage and stored supplemental feed are to last, dry and less desirable cows must be sent to market. Careful culling of such animals will make certain that the best breeding cows get all of the available forage and hay to maintain their vigor.

Market culls early.—Since both wet and dry cows gain very little at best and often start losing weight early in June of drought years, holding cattle that have been culled for sale only invites increased losses. Early sales save range forage for the best cows, reduce the amount of supplemental feed required, and permit higher financial returns from heavier cattle. Although late fall prices are occasionally higher than those in midsummer, over a 30-year period the average Montana ranch price for cattle has declined through September, October, and November to below July and August levels (2).

Calves, too, should be sold earlier than usual in drought years. Cows can be maintained in better condition on scanty forage and hay supplies if calves are weaned. Since calves will not develop normally anyway, it

is better practice to dispose of them before they shrink badly. Unless calves are sold while they are in fair condition, thus keeping cows on the range, it may be necessary to sell both cows and calves later on when forage has been exhausted and animals are in poor condition.

Alter the plan of seasonal use.—Supplemental feed requirements may be lessened by altering the pattern of seasonal range use somewhat, taking advantage of the early growth habits of drought-resistant plants. Plan to use the most green forage possible by grazing first the areas where early starting species such as Sandberg bluegrass and threadleaf sedge are dominant early in the spring. Otherwise, the forage produced by these early species may be lost through weathering or eaten by grasshoppers that frequently accompany drought in the northern Great Plains.

Use care in restocking the range.—When drought periods end, efforts to promptly increase the size of the herd may do irreparable damage to the range. Range plants greatly reduced from their original density may recover only very slowly if grazed too heavily at the first sign of more favorable rainfall. Cattle numbers should be increased only after the forage plants have recovered their vigor; the increase should be gradual, following increased density of the more palatable species that are typical of good short-grass ranges.

SUMMARY

In the northern Great Plains severe drought is an ever-present threat to livestock operations. From 1878 to 1939, drought occurred on the average of once every 5 years. A major problem facing range livestock producers in this vast area is how to manage their range and livestock to minimize the effects of this recurring hazard.

From 1932 to 1936 the Forest Service, in cooperation with the United States Bureau of Animal Industry, and the Montana Agricultural Experiment Station, conducted a cattle grazing study at the United States Range Livestock Experiment Station near Miles City, Mont. The study was to determine the rate of range stocking that would sustain high forage and livestock production, and stabilize range operations, but severe drought occurred in 1934 and 1936 and disturbed the original plan. However, valuable information on the effects of drought was obtained.

Two sets of six pastures, typical of northern Great Plains range in good condition, were established for summer and winter grazing. Two pastures in each set were stocked heavily, 2 moderately, and 2 lightly; 20 uniformly high-grade Herefords were assigned to each rate of stocking. An extensive system of records was kept on how the range and the cattle were affected by weather and the various rates of stocking.

Over the 4-year period 1934-37, density of the six most important range forage species declined to 8.5 percent of the 1933 level in all range pastures regardless of the planned rate of stocking. On plots entirely ungrazed, the trends in densities of the principal species were sharply downward from 1935 to 1937. Drought reduced forage supply so drastically that only 36 and 23 percent as much unsupplemented grazing use was obtained from the pastures in 1934 and 1936 as was possible in 1933, the year before the first drought occurred. This sharp reduction in range forage made heavy supplemental feeding necessary.

The effect of drought was equally as severe on cattle production as it was on the forage supply. In addition to losses in weight by breeding cows, the drought reduced the number of calves produced and the average weaning weight under all intensities of stocking.

Conservative stocking is a means of minimizing costs while increasing returns. Conversion of the direct effects of severe drought into losses in the over-all operation shows that costs for hay and range forage per cow during drought averaged more than \$45 compared with less than \$4 during 1933. In 1934 feed costs per cow actually far exceeded the dollar value of the calves produced. On heavily stocked ranges feed costs averaged \$7 to \$10 more per cow during 1934 than on moderately and lightly stocked ranges. Figured at the estimated average value of calves sold in eastern Montana, calves produced by 20 cows on heavily stocked range failed to return total feed costs in any of the 3 years 1934-36. On the moderately and lightly grazed ranges, however, returns were about 80 percent greater than feed costs in both 1935 and 1936.

Data from this experiment and experience gained over the years indicate some practical means of managing northern Great Plains ranges and the cattle grazing thereon to minimize the effects of the next drought. Basic management practices include (1) conservative stocking, (2) adequate supplemental feed supplies, (3) provision for adequate salt and stock water, (4) early breeding season, (5) seasonal use of the range, (6) uniform distribution of livestock over the range, and (7) inclusion of both steers and cows in the commercial herd.

Recommended adjustments during drought years include (1) close culling of dry cows, undesirable bred cows, and steers; (2) early marketing of culled animals; (3) changes in the plan of seasonal use to utilize early starting forage species; and (4) caution in restocking the range before good vigor has returned to the forage plants.

COMMON AND SCIENTIFIC NAMES OF PLANTS MENTIONED

GRASSES AND GRASSLIKE PLANTS

Bluegrass, Sandberg (syn. little bluegrass).....	<i>Poa secunda</i>
Buffalograss.....	<i>Buchloe dactyloides</i>
Grama, blue.....	<i>Bouteloua gracilis</i>
Needle-and-thread.....	<i>Stipa comata</i>
Sedge, threadleaf (niggerwool).....	<i>Carex filifolia</i>
Wheatgrass, bluestem (western wheatgrass).....	<i>Agropyron smithii</i>

BROWSE—SHRUBS

Pricklypear, plains.....	<i>Opuntia polyacantha</i>
Sagebrush, silver.....	<i>Artemisia cana</i>
Saltbush, Gardner.....	<i>Atriplex Gardneri</i>
Saltbush, shadscale.....	<i>A. confertifolia</i>

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